Use of Error Factors in Determining a Miner's Overexposure to DPM

The DPM permissible exposure limit (PEL) is 160 micrograms of total carbon (TC) per cubic meter of air (160_{TC} µg/m^3).

1. TC from a personal sample **must exceed** 160 µg/m^3 times the error factor (EF) for TC to result in a miner's overexposure to DPM. The EF for TC is 1.192. Thus, it follows that the miner **is not overexposed** to DPM when TC from the miner's personal sample **is less than or equal to** 160 µg/m^3 times the EF for TC as demonstrated below:

$$TC \leq 160 \text{ x [EF for TC]}$$
$$TC \leq 160 \text{ x } 1.192$$
$$TC \leq 190.72$$

Per MSHA's practice to round up to the next higher integer, 190.72 is rounded to 191. Therefore, a miner **is not overexposed** to DPM when TC < 191 ($\leq$ changed to < because 191 is greater than 190.72)

2. When TC from a full-shift personal sample **is equal to or greater** than 191 ug/m^3, MSHA will evaluate the EC content of the personal sample as follows to confirm that the TC exposure is not the result of organic carbon interferences:

The miner **is overexposed** to DPM when EC on the miner's personal sample for TC is greater than 160 times the EF for EC. The EF for EC is 1.095. This relationship may be expressed mathematically as:

$$EC > 160 \text{ x [EF for EC]}$$
$$EC > 160 \text{ x } 1.095$$
$$EC > 175.2$$
$$175.2 \text{ is rounded up to next higher integer} = 176$$
$$EC \geq 176 \quad (> \text{ changed to } \geq \text{ because 176 is already higher than 175.2})$$

Therefore, a miner is overexposed to DPM when EC on the personal sample equals or is greater than 176 µg/m^3.

In addition, when the miner's full-shift exposure to EC on the personal sample is less than 176 ug/m^3, **an overexposure may still exist** if the full-shift exposure to EC on the personal sample times the average TC to EC ratio of one or more area samples is greater than 160 x EF for TC_{adj}.[1]   This may be expressed mathematically as:

$$TC_{adj} > 160 \text{ x [EF for } TC_{adj}]$$

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[1] Multiplying EC on the personal sample by the average TC to EC ratio of one or more area samples obtained where non-diesel OC interferences are likely to be negligible results in the TC concentration of the personal sample without OC interferences. This "adjusted" TC value is designated as TC_{adj} to differentiate it from TC, which refers to total carbon determined by the ordinary method of EC + OC.

The value of the EF for TC_{adj} depends on the number of area samples used for determining TC_{adj}. This EF ranges from 1.259 when 1 area sample is used to 1.121 when 10 area samples are used (unlikely we would ever encounter a situation where more than 10 area samples would be required - - 1 to 3 area samples would be adequate in the vast majority of cases). In the following table, the column labeled "citation threshold" shows the values of 160 times the EF for TC_{adj} for each case from 1 up to 10 area samples (result rounded to the next higher integer).

Number of Area Samples Included in Average TC:EC Ratio	Citation Threshhold for TC_{adj}
1	202
2	192
3	187
4	185
5	183
6	182
7	182
8	181
9	180
10	180

In summary, the miner is overexposed to DPM when EC < 176 **and** TC_{adj} is equal to or greater than the corresponding value from the table depending on the number of area samples used. For example, if one area sample is used, a miner **is overexposed** when:

EC < 176

and

$TC_{adj} \geq 202$

If three area samples are used, a miner **is overexposed** when:

EC < 176

and

$TC_{adj} \geq 187$